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The Scallop Fishery in Newfoundland and Labrador Becomes Beleaguered

La pêche des pétoncles est en difficulté à Terre-Neuve et au Labrador

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Abstract

In 2000, the scallop fishery was in the final year of a three-year (1998-2000) Management Plan. Nominal landings, estimated at 2,647t , were down 12% from the previous year making it the fourth consecutive year of decline. The number of active vessels prosecuting scallops is down slightly (72 vs. 79 in 1999). As in 1999, effort diversion primarily into crab and shrimp, together with declining availability of scallop, has resulted in catches typically short of pre-emptive catch limits. The nominal catch now is only about one-quarter of the 11,266 t peak in 1996. Overall, excluding Labrador, only 23% of the available TAC (2,647t out of 11,430 t) was taken.

Résumé

La pêche des pétoncles en 2000 en était à sa dernière année d'un plan de gestion triennal (1998-2000). Pour une quatrième année onsécutive, les débarquements nominaux étaient en baisse; estimés à 2 647 t, ils ont reculé de 12 % par rapport à l'année précédente. Le nombre de pétoncliers actifs a diminué légèrement (72 contre 79 en 1999). En date de 1999, la réorientation de l'effort, principalement vers le crabe et la crevette, conjuguée à la moins grande disponibilité de pétoncles, s'est traduite par des captures généralement inférieures aux limites de captures anticipées. Les captures nominales ne correspondent désormais qu'au quart environ des captures sans précédent de 11 266 t en 1996. Dans l'ensemble, en excluant le Labrador, seulement 23 % du TAC disponible (2 647 t sur 11 430) ont été capturés.

Introduction

Two species of scallop are found in commercial densities in Newfoundland and Labrador: the sea scallop, Placopecten magellanicus and the Iceland scallop, Chlamys islandica.

The sea scallop, the larger of the two, is restricted to the northwest Atlantic. It ranges from the shallow waters along the north shore of the Gulf of St. Lawrence to deeper waters as far south as Cape Hatteras, U.S.A. It's distribution is thought to be temperature limited. Both Canadian and U.S. fishermen have long exploited the species. In Newfoundland, it is fished both recreationally and commercially, especially along the west and south coasts. Offshore, the species is restricted to St. Pierre Bank (NAFO Subdiv. 3Ps), usually in depths less than 30 fms. A pulse fishery occurs here as and when significant recruitment occurs. The fishery is prosecuted intermittently by Maritimes'- based offshore vessels. An enterprise allocation (EA) has been in place since 1989. Currently, it is under a pre-emptive TAC of 415 t. Advice for and management of the offshore fishery is through the Offshore Scallop Advisory Committee (OSAC). Conservation practices for the sea scallop include catch limits, seasons and size regulation, the latter through a minimum meat count, which seeks to discourage growth over-fishing.

The Iceland scallop is widely distributed within the sub-arctic. In Newfoundland, populations are normally found in waters from 30-100 fms, usually on hard bottom with variable substrate composition, consisting largely of sand, gravel, shell fragments, and stones. Being a filter feeder, it is most abundant in areas with strong currents such as in the Strait of Belle Isle, Gulf of St. Lawrence. Commercial aggregations also occur over St. Pierre Bank (NAFO Subdiv.3Ps), Grand Bank (Div. 3LN), and off the Labrador(Div.2HJ) (Fig. 1). In Canada, Iceland scallops are prosecuted in Newfoundland and Labrador and in Quebec. Elsewhere, they are harvested in Greenland, Iceland, Norway and Russia. The directed fishery for the species in Newfoundland began in the Strait of Belle Isle in 1969, but later expanded onto St. Pierre Bank (1989) and the Grand Bank (1993). On St. Pierre Bank, the Iceland scallop is sometimes intermixed with sea scallop. Aggregations within each area are now regulated by catch levels and by seasons. Cumulative removals from Newfoundland and Labrador have declined significantly and are now only about one-quarter of what it was just four years ago. In part this is due to the greater relative availability of other species, notably crab and shrimp, but also due to declines in scallop abundance throughout the areas once supporting lucrative fisheries.

The Iceland scallop resource in 4R is updated from a research survey in 2000. For other aggregations, only fishery performance is summarized.

In 2000, the scallop fishery was in the final year of a three-year (1998-2000) Management Plan. Nominal landings, estimated at 2,647t, were down 12% from the previous year making it the fourth consecutive year of decline (Table 1, Fig. 2). The number of active vessels prosecuting scallops is down slightly (72 vs. 79 in 1999, Table 2). As in 1999, effort diversion primarily into crab and shrimp, together with declining availability of scallop, has resulted in catches typically short of pre-emptive catch limits. The nominal catch now is only about one-quarter of the 11,266 t peak in 1996. Overall, excluding Labrador, only 23% of the available TAC (2,647t out of 11,430 t) were taken (Table 3).

NAFO Div. 3LNO – Grand Bank

Fishery

In 2000, eight vessels participated in the Iceland scallop fishery over the Grand Bank, up from six the previous year but well below the 21 vessels recorded in 1998 (Table 4). Only 4.9% (335t out of 6,800 t) of the available TAC for Divisions 3LNO were taken (Table 3).

Although total removals better than doubled in 2000 (335t vs. 138t in 1999), it still is well short of the 9,454 t recorded in 1996. As in previous years, the majority of the catch, 295 t, came from aggregations around the Lilly Canyon and Carson Canyon (NAFO Div. 3N, Tables 4 and 5). Catch rates here slipped 8% from that estimated in 1999 (68 kg/tow vs. 74 kg/tow), but down 31 % from 98 kg/tow in 1995, when deposits here were first commercialized (Table 6). Individual meat-weight distributions show a tendency toward slightly smaller meats (Fig. 3) compared to 1999. Also, estimates of meat counts (no. of meats/unit weight) were up slightly to 42/lb from 39/lb in 1999 (Table 7).

None of the aggregations within 3Nf, 3LN and Eastern 3L was fished in 2000. Aggregations close to shore on Cape Ballard Bank yielded 35 t out of a 500 t TAC. Only 5 t were taken from the remainder of 3LNO outside of the "boxed" areas, also under a pre-emptive catch limit (2,500t).

Research – No new information

NAFO Subdiv. 3Ps – St. Pierre Bank

Iceland scallop

Fishery

Canadian Zone

Iceland scallop aggregations here were first exploited in 1989. Landings peaked in 1997 (5,245 t) but have since declined. In 2000, only 32% of the overall pre-emptive TAC (1,134 t out of 3, 500 t, Table 3) was taken, similar to the catch in 1999 (1,188 t). Most (676 t out of 1,134 t or 60%) of the catch was drawn from offshore aggregations. As in 1999, very few vessels returned to scallop fishing. The number of vessels participating remained unchanged (35 vs. 34).

Exploitation of Iceland scallop aggregations off St. Mary's the Capes (Perch Rocks) commenced in the early 1990's. A dramatic increase in effort (695 fishing days) was evident in 1997. Since then both catch and effort have declined. In 2000, only 259 days were expended and only 65% of the pre-emptive TAC (453t out of 700 t) was taken. The majority of the catch (373 t or 81%) came from small vessels (< 45ft. L.O.A.). Proximity to shore remains the most compelling consideration to preferentially harvesting these beds to those located offshore, even if catch rates have fallen to their lowest level (34 kg/tow) since 1997(52kg/tow) (Table 8). On the average, individual meat weight was higher in 2000 than in the previous year resulting in significantly lower counts (35/lb vs. 42/lb, Table 9, Fig. 4).

Residual areas outside of discrete TAC "boxes" (Management Areas 10 and 11), but also under pre-emptive catch limits (1,000 t per area in 2000), yielded a further 657 t or 33% of the TAC. Both Eastern St. Pierre Bank (0 t) and Western St. Pierre Bank (19 t) contributed little to the overall removals from this area in 2000. Some sea scallop caught both offshore and in Placentia Bay may be included in the landings, as there was no attempt made dockside to distinguish them.

Trans-boundary Zone

Neither Canada nor France has fished these aggregations for Iceland scallop since 1998. When last this area was surveyed (1998), it was estimated that more than half (55%) of scallops sampled were dead. A severe epidemic of predatory starfish has contributed to significant scallop mortality.

Research – No new information.

Sea scallop

Fishery

After a two-year hiatus, the Maritimes' based offshore sea scallop fleet returned to St. Pierre Bank. Approximately 34 t were taken. Catch rate was higher than in 1997 when last the offshore vessels fished the Bank (30.8kg/hr vs. 20.7 kg/hr). In the absence of new biological information, a pre-emptive TAC of 415t has been in place for the sea scallop since 1996. Newfoundland-based vessels fishing for the Iceland scallop sometimes catch and retain sea scallop. Regulations currently permit a 10% tolerance. As scallops are shucked at sea and only "meats" landed, species discrimination for monitoring purposes is fraught with difficulty.

Research – No new information.

NAFO Subdiv. 4R – Strait of Belle Isle

Fishery

With the exception of a 4-year hiatus (1975-78), the fishery here has persisted since 1969 (or 31 years) (Table 10, Fig. 5). It is the anchor scallop fishery in Newfoundland and Labrador. Scallop beds here are considered to be a single stock for assessment purposes. The fishery is regulated by TAC (weekly and annual), and by area. In 2000, the TAC (1,100 t vs. a recommended level of 930 t) was in the final year of a 3-yr (1998-2000) Management Plan. Even though the prescribed catch limit is for the entire area, the fleet typically converges on high-density scallop aggregations (beds). Vessels here make daily excursions and land a fresh product. In 2000, nearly all (99.7%) scallops were shucked at sea. The number of active licenses has ranged from a high of 107 (1985) to a low of 11 (1980). Only 32 vessels participated in the fishery in 2000. This is the lowest number of vessels that remained active in this area in nearly a decade (Table 10).

Number of scallop-days-at-sea in 2000 increased 24% from 1999 (1458 days vs. 1177 days) while the catch/day decreased 17% to 736 kg/day from 889 kg/day. Whereas it took a given enterprise 2-3 days to reach it's weekly catch limit of 800 lb. of meats in 1999, fishers frequently required 5-6 days in 2000 and there were weeks when they could not even reach that limit.

Aggregations to the south have been particularly hard hit throughout the 1990's with removals sometimes, as in 1998, exceeding 90% of the total (Fig. 6). An attempt was made in 1999 to re-distribute some of this effort to the north. With management of the resource increasingly co-opted to stake holders, it was agreed in 1999 to partition the removals equally between north and south of 51° 25'N. Unfortunately, this did not occur in 1999. The proposed strategy was re-visited in 2000, resulting in the TAC (1,100 t) being partitioned 40:60 (or 440:660 t) in part to redress the delayed implementation. In 2000, it is estimated that 663 t were taken from the north vs. 410 t to the south as prescribed (Table 11).

Non-standardized CPUE (kg/tow) computed from fishing logs is down 11% from 1999 (26.6 kg/tow vs. 29.9 kg/tow), making it the second consecutive year of declines greater than 10% (Table 12). Effort (%), removals (%), for the whole area, by zone (north and south of 51°25'), CPUEs by week, year and vessel-size class are summarized in Tables 13–15.

Also, in consultation with stake- holders, a corridor 5 mi. wide across the Strait of Belle Isle has been established where scalloping will be prohibited (Fig. 7). The closure became effective in 2000. Encompassing approximately 106.5 n.mi.^{2} out of 1635.5 n. mi. ^{2} (or 6.5%) of Fishing Area 14A, the "refugium" is intended to provide an opportunity to examine if settlement and recruitment would be facilitated in the absence of fishing. This indeterminate closure will assist Science in evaluating the extent to which a "pulse" fishing strategy might be incorporated into a management plan for Iceland scallop to achieve long-term sustainability.

Yet another failed attempt, the third in as many years, was made jointly by Science, Department of Fisheries and Aquaculture and the Fish, Food and Allied Workers Union (FFAW) to deploy spat collectors to determine reproductive success of Iceland scallop in 4R.

Research

A 10-day research survey (August 22-31, 2000) was conducted in 4R (Strait of Belle Isle), last assessed in 1997, to update resource status. All fishing sets were completed with an 8-ft. New Bedford scallop rake equipped with 3" rings and interconnected with three and four links on the top and bottom respectively. Mean catch per tow and depths fished are reported in Table 16.

Size Composition

Notwithstanding repeated claims to the contrary, the continued absence of pre-recruits has long been a recurrent concern in this fishery. Research and at-sea observer coverage in 2000 again indicated that size of scallop here has remained unchanged for five consecutive years (Tables 17 and 18, Fig. 8). The research survey in 2000 estimated that pre-recruits contributed to less than 0.5% of the total numbers caught and 0.10% by weight (Table 19). Scallop aggregations here now consist predominantly of large (old) scallops with little potential for further growth.

Size-distribution of cluckers, on the other hand, indicates a relatively higher percentage of small scallops (Fig. 9). As hypothesized previously (Naidu et al. 1998, 2000), this might be indicative of selective mortality to young scallops through intense fishing activity.

Scallops here depict a history of encounters with fishing gear as manifested by the frequency of occurrence of supernumerary "shock" or "stress" rings. This feature is most likely attributable to sub-lethal past encounters with fishing gear. Nearly a third (34%) of all scallops examined from this area in 1999 and 2000 (N= 3278) carried the indelible evidence (Table 20). This observation supports the contention that exploitation rates here have generally been high.

Meat Yields

Overall meat yield (biological) remained unchanged in 2000 (12.2% vs. 12.4% in 1999). Meat counts were slightly higher (31 vs. 28/lb.) (Table 21).

Natural Mortality

Natural mortality, computed from percent occurrence of cluckers (persistent paired valves still attached at the hinge line), was estimated as per Dickie (1955), Mercer (1974) and Naidu (1988) at 0.20. No significant differences were detected from previous years (Table 22). Estimates of natural mortality are also reported for each of the two zones – north and south of 51^0 25' N.

Starfish

Relative to other areas (3LNO), starfish abundance is not considered problematic (Table 23, Naidu et al. 1998). Catastrophic mortalities (M=0.8) have been reported over St. Pierre Bank, where an infestation of starfish decimated populations of Iceland scallops (Mahe and Briand, 1998). There is no evidence in 4R of extreme starfish-mediated mortality to scallops.

Stock status

Estimates of highly aggregated populations are biased frequently through sampling error attributable in part to the assumption of spatial homogeneity of density over a given area and the assumption of equal catchability of the target species over the entire area surveyed, related to variable bottom type.

Improved characterization of the sea bottom using an acoustic seabed classification system such as *RoxAnn* permits mapping the distribution of seabed types favorable for the occurrence of sedentary, epibenthic or infaunal communities. Dedicated *RoxAnn* transects were first run across the Strait of Belle Isle in 1995.Twelve east-to-west lines between parallels 51° 01'N and 51° 55'N, each spaced five-miles apart and along 255mi had been completed over an area estimated at 847n.mi^2. Acoustic information assembled opportunistically while steaming from one transect to another or from one fishing station to the next and during fishing tows is continuously incorporated into the seabed classification database. Total area considered favorable for the presence of scallop had then

been estimated at 282 n.mi.^{2}. In 2000, eleven new transects along 221n.mi were run in between those completed in 1995, further improving our understanding of the distribution of seabed types over the target area. In sum, we have since 1995 completed 23 transects along 446 n.mi.(Fig. 10). Large areas still exist in which acoustic data is low or non-existent. Where acoustic data on bottom types were unavailable, information on fishing effort distribution was used in combination with *RoxAnn* outputs in the delineation of areas favorable for the presence of scallop. Censusing and interpreting the distribution of bottom types within the Strait of Belle Isle is fraught with difficulty. The sea bottom here is highly variable and heterogeneous with respect to substrate composition. This renders unambiguous characterization of even small areas problematical, especially that gear efficiency may be expected to vary. In fact, only five (out of 63) of the 0.5mi tow tracks in 2000 were completed in unambiguously uniform bottom. This is problematical for abundance estimation using the swept area methodology given that gear efficiency varies both within and between tows.

The composite acoustical data and distribution of fishing effort was used to better infer distribution of scallop beds in the area and to optimize survey design. This approach allowed for a more efficient stratification scheme than a simple random survey based on some artificial stratifying variable such as depth. Configuration of scallop beds in the area was modified in 2000 and the number of scallop beds reduced from six (1997) to three (Fig. 11).

While the entire area (612 n.mi.^{2}) within the three defined beds was surveyed in 2000, the abundance estimate within each area was reduced by the ratio of "good" to "bad" bottom. We attempted to do this by inspecting sea-bottom characteristics along each of the 63 sets completed in the area. *RoxAnn* outputs along each half-mile tow were examined to determine proportions of "good" to "bad" bottom. The total area surveyed was then adjusted to reflect the cumulative ratio of "good" to "bad" bottom. This was done separately for each of the three beds and total fishable biomass estimated.

Overall, it was estimated that only 50% of the area (300 n.mi.^{2} out of 612.2 n.mi.^{2}) surveyed was considered suitable for the presence of scallop. Based on an efficiency-corrected (20%) swept area methodology, it is estimated that the biomass now is between 7000t- 10,600t, round with a mean of 8,800 t (Table 24), down from the mean estimated in 1997 (9,300 t). The recommended catch based on 10% of the mean would be 700t-1,060 t with a mean at 880 t.

Labrador

Fishery

As per recent years, inshore aggregations here were again harvested with nominal catches estimated at 105 t, down from 644 t in 1999 (Table 1).

Research

There has been no directed research into scallop aggregations in Labrador.

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Table 1. Nominal catches (t, round) of Iceland scallop from Newfoundland, 1969-2000. The 2000 statistics are provisional.

Year	4R	3Ps		Div. 3LNO			Labrador	Total Iceland		Sea Scallops (offshore 3Ps)
				3L	3N	3O				
1969	248							248		
1970	192							192		
1971	167							167		
1972	2,596							2,596		
1973	2,189							2,189		
1974	244							244		
1975	-							-		
1976	-							-		
1977	-							-		
1978	-							-		191
1979	450							450		8
1980	1,133							1,133		291
1981	1.530							1,530		-
1982	349							349		5,951
1983	371							371		4,930
1984	1,523							1,523		3,428
1985	2,546							2,546		440
1986	1,942							1,942		1,270
1987	1,141							1,141		448
1988	447							447		8,176
1989	155		36					191		2,756
1990	88		507					595		1,270
1991	457		755					1,212		1,112
1992	1,296		5,967	20	2	0		7,285		556
		Core	Non-core							
1993	2,122	-	667	489	325	3		3,606		1,079
1994	2,294	-	440	86	3,844	11		6,675		407
1995	1,497	230	831	101	6,400	0		9,059		565
1996	1,204	306	302	406	9,048	0		11,266		153
1997	1,205	122	5,245	383	3,569	34	653	11,211		25
1998	1,307	0	2,763	187	1,122	1	1,190	6,570		-
1999	1,046	0	1,188	4	134	0	644	3,016		-
2000	1,073	0	1,134	35	300	0	105	2,647		34

Table 2. Fishing activity (number of active licences) for Iceland scallop in NAFO Div. 4R + 3LNOPs, 1996-2000

Area	1996	1997	1998	1999	2000
4R	46	45	41	42	32
3LNOPs	228	133	79	37	40
Total	274	178	120	79	72

Table 3. Iceland scallop fishing aggregations, catch limits and removals from Newfoundland, 2000.

Area	TAC (t, round)	Removals (t, round)
Cape Ballard Bank (CBB) (<45')	250	21
Cape Ballard Bank (CBB) (>45')	250	14
Eastern 3L (EPL)	1,000	0
3LN	1,500	0
3Nf	400	0
Lilly/Carson Canyons (LCC)	900	295
Remainder of 3LNO	2,500	5
Total	6,800	335
Perch Rocks/Keys (PRK)(<45')	350	373
Perch Rocks/Keys (PRK) (>45')	350	85
Eastern St. Pierre Bank (EStP)	300	0
Western St. Pierre Bank (WStP)	500	19
Area 10 – North of 46°30'N	0	68
Area 10 – South of 46°30'N	1,000	74
Area 11 – North of 46°30'N	0	111
Area 11 – South of 46°30'N	1,000	404
Total (Canadian)	3,500	1,134
Transboundary Area (CORE)	30	0
4R	1,100	1,073
Labrador	0	105
TOTAL	11,430	2,647

Table 4. Nominal catch (t, round) and effort (no. vessels) in the fishery directed at Iceland scallops in NAFO Div. 3LNO, 1992-2000.

Year	No. of Vessels	Div. 3L	Div. 3N	Div. 3O	Total Div. 3LNO
1992	1	20	2	0	22
1993	10	489	325	3	817
1994	57	86	3,844	11	3,941
1995	48	101	6,400	0	6,501
1996	52	406	9,048	0	9,454
1997	52	383	3,569	34	3,986
1998	21	187	1,122	1	1,310
1999	6	4	134	0	138
2000	8	35	300	0	335
Totals		1,711	24,744	49	26,504

Table 5. Summary of TACs, effort and removals for NAFO Div. 3LNO, 2000.

Area	TAC (t)	No. of Fishing days*	Removals (t)	
			Log estimates*	Dockside monitor
Eastern 3L (EPL)	1,000	0	0	0
3LN (3LN)	1,500	0	0	0
Lilly/Carson Canyons (LCC)	900	123	250	295
3Nf (3Nf)	400	0	0	0
Cape Ballard Bank (CBB)	500	15	18	35
Remainder of 3LNO (R3LNO)	2,500	10	8	5
Total	6,800	148	276	335

* based on log estimates only. Approximately 82% of total removals accounted for by log records

Table 6. Monthly non-standardized CPUE estimates for the Lilly/Carson Canyon area of NAFO Div. 3N, 1995-2000.

Month	Removals[1] (t, round)	Fishing days	CPUE (kg/tow)
August	69	26	87
September	123	62	58
October	38	23	71
November	20	12	77
Overall 2000	250	148	68
1999	124	45	74
1998	631	213	79
1997	2,495	920	77
1996	2,696	904	86
1995	3,023	977	98

[1] sum of daily log estimates x9.2

Table 7. Percent meat-count frequency in port samples from the Lilly/Carson Canyons (NAFO Div. 3N), 1998-2000.

Meat count (#/lb)	1998	1999	2000
10-19	-	0.3%	0.1%
20-29	2.6%	11.8%	5.1%
30-39	18.9%	35.8%	30.4%
40-49	30.7%	30.7%	40.0%
50-59	25.0%	14.7%	15.6%
60-69	14.0%	4.5%	6.2%
70-79	5.8%	1.4%	2.1%
80+	3.0%	0.7%	0.6%
$\bar{x}$ meat wt. (g) (± S.D.)	9.62 (±2.52)	11.62 (± 3.10)	10.81 (±2.48)
N	3,368	2,989	2,534

Table 8. Monthly non-standardized CPUE estimates (kg/tow, round) for various aggregations under TAC within NAFO Div 3Ps, 1997-2000.

Month	Perch Rocks/Keys			Eastern St. Pierre Bank			Western St. Pierre Bank		
	Removals[1] (t, round)	Fishing Days	CPUE (kg/tow)	Removals[1] (t, round)	Fishing Days	CPUE (kg/tow)	Removals[1] (t, round)	Fishing Days	CPUE (kg/tow)
April	85	52	30	-	-	-	-	-	-
May	87	61	32	-	-	-	7	5	35
June	60	45	31	-	-	-	-	-	-
July	140	87	39	-	-	-	-	-	-
August	14	11	35	-	-	-	-	-	-
September	0	3	0	-	-	-	-	-	-
October	-	-	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-	-	-
Overall 2000	386	259	34	0	0	-	7	5	35
1999	451	331	35	75	33	76	51	24	51
1998	842	453	51	13	12	24	508	196	62
1997	1197	695	52	1321	659	58	1497	388	128

[1] based on log estimates

Table 9. Percent meat-count frequency and mean meat weight (g) for commercially-shucked scallops from the Perch Rocks/Keys area of NAFO Div. 3Ps, 1999-2000.

Meat Count (# /lb)	1999	2000
10-19	0	2.0
20-29	8.0%	23.3%
30-39	32.1%	31.6%
40-49	31.1%	24.6%
50-59	16.1%	11.7%
60-69	6.8%	4.8%
70-79	3.5%	1.3%
80+	2.5%	0.7%
$\bar{x}$ meat wt (g) (±SD)	10.86 (±2.92)	12.80 (±4.09)
N	1,925	3,729

Table 10. Iceland scallop landings and effort statistics[1] from the Strait of Belle Isle. A species-specific conversion factor of 9.2 is used throughout. The 2000 statistics are provisional.

Year	Landings (t, round)	No. of active licences	Effort (boat days)	Catch per unit effort (unadjusted)	
				kg (round) /boat/day	t (round) /boat/year
1969	248	-	-	-	-
1970	192	-	-	-	-
1971	167	-	-	-	-
1972	2596	-	-	-	-
1973	2189	-	-	-	-
1974	244	24	269	907	10.7
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	-	-	-	-
1978	-	-	-	-	-
1979	450	16	459	981	28.1
1980	1133	14	774	1463	80.9
1981	1530	24	1262	1212	63.3
1982	349	24	413	845	14.5
1983	371	23	485	765	16.1
1984	1523	46	1272	1197	33.1
1985	2546	107	2887	882	23.8
1986	1942	88	2270	856	22.1
1987	1141	57	n/a	-	20.0
1988	447	30	n/a	-	14.9
1989	155	14	n/a	-	11.1
1990	88	11	n/a	-	8.0
1991	457	24	n/a	-	19.0
1992	1296	72	n/a	-	18.0
1993	2122	71	n/a	-	29.9
1994	2294	80	2769	828	28.7
1995	1497	43	2113	708	34.8
1996	1204	46	1385	869	26.2
1997	1205	45	1313	918	26.8
1998	1307	41	1364	959	31.9
1999	1046	42	1177	889	24.9
2000	1073	32	1458	736	33.5

n/a = not available

[1] Sources of landing and effort statistics:
1969-81: CAFSAC Res. Doc. 82/02
1982-83: CAFSAC Res. Doc. 86/77
1984-90: Can. MS Rept. 2154
1990-92: Science Branch, Gulf Region
1993: Statistics Branch, Newfoundland Region
1994-00: Science Branch, Newfoundland Region

Table 11. Distribution of fishing effort north and south of 51°25'N in the Strait of Belle Isle, 2000.

Area	DMP		Log data	
	Removals (t)	Effort	Removals (t)	Effort
South	410 (38%)	6 weeks (38%)	354 (39%)	498 (38%)
North	663 (62%)	10 weeks (62%)	559 (62%)	830 (62%)
Total	1,073	16 weeks	913	1,328 days

Table 12. CPUE estimates (non-standardized) for the Iceland scallop fishery in the Strait of Belle Isle 1994-2000. Total removals for 1994-96 are based on combination of sales slip and log estimates. Total removals for 1997-2000 are from the Dockside Monitoring Program.

Year	Month	Removals (t, round)	Fishing days	CPUE (kg/tow)
1994	May	1.6	3	21.3
	June	822.9	936	37.6
	July	1,004.5	1,192	35.4
	August	252.1	369	28.6
	September	211.9	266	29.5
	October	1.1	3	29.0
	TOTALS	2,294.2	2,769	34.5
1995	June	259.9	352	28.1
	July	506.7	697	28.6
	August	477.5	627	29.9
	September	234.5	391	25.9
	October	18.6	46	22.7
	TOTALS	1,497.1	2,113	28.6
	% change 1994-95	-35%	-24%	-17%
1996	June	374.8	460	29.0
	July	476.1	532	32.2
	August	331.9	363	36.7
	September	20.4	29	33.1
	October	0.8	1	33.6
	TOTALS	1,204.1	1,385	32.2
	% Change 1995-96	-20%	-34%	+13%
1997	June	351.8	383	31.8
	July	446.2	527	35.8
	August	278.4	397	34.0
	September	1.9	5	24.9
	Unaccounted by logbook	126.5	1	-
	TOTALS	1204.8	1313	34.0
	% Change 1996-97	0%	-5%	+6%
1998	June	471.0	516	34.0
	July	459.5	572	33.1
	August	102.5	135	32.2
	September	106.4	141	33.1
	Unaccounted by logbooks	167.6	-	-
	Totals	1,307	1,364	33.6
	% change 1997-98	+8%	+4%	-1%
1999	June	357.9	449	29.7
	July	435.9	532	30.7
	August	144.5	196	28.1
	Unaccounted by logbooks	108.1	-	-
	Totals	1046.4	1,177	29.9
	% change 1998-99	-20%	-14%	-11%
2000	June	247.6	355	27.7
	July	369.4	503	27.7
	August	306.0	463	24.3
	September	80.5	135	27.2
	Unaccounted by logbooks	69.9	2	-
	Totals	1,073.3	1458	26.6
	% Change 1999-2000	+3%	+24%	-11%

Table 13. Iceland scallop effort, removals and CPUE's, north and south of 51°25'N in the Strait of Belle Isle, 1994-2000. (CPUE's based on log entries only, not on dockside monitoring.)

Year	Total		South of 51°25'N		CPUE (kg/tow)		
	Removals (t, round)	Effort (days)	Removals (%)	Effort (%)	Overall	North of 51°25'	South of 51°25'
1994	2,294	2,769	43	42	34.5	29.9	38.1
1995	1,497	2,113	46	47	28.6	28.4	28.5
1996	1,204	1,385	67	61	32.2	22.8	40.7
1997	1,205	1,313	83	80	34.0	21.7	38.0
1998	1,307	1,364	94	93	33.6	23.5	34.4
1999	1,046	1,177	70	70	29.9	28.7	30.4
2000	1,073	1,458	39	38	26.6	25.1	28.5

Table 14. Within-season, non-standardized catch rates for Div. 4R scallop, 2000.

Week	Dates	Removals (t, round)	Fishing days	CPUE (kg/tow)
1	June 5-11	41.0	57	28.2
2	June 12-18	67.6	107	25.7
3	June 19-25	91.4	121	28.6
4	June 26-July 2	52.8	79	28.8
5	July 3-9	68.1	113	27.2
6	July 10-16	89.1	114	30.2
7	July 17-23	95.5	129	27.4
8	July 24-30	89.3	115	26.2
9	July 31 – August 6	78.4	109	24.7
10	Aug 7-13	76.8	118	24.6
11	Aug 14-20	64.7	104	23.2
12	Aug 21-27	52.7	81	25.3
13	Aug 28-Sept 3	57.3	80	25.2
14	Sept 4-10	34.5	54	27.4
15	Sept 11-17	26.9	48	27.6
16	Sept 18-24	17.3	27	26.6
Unknown	Not accounted in logs	69.9	2	-
Overall		1073.3	1458	26.6

Table 15. Estimates of CPUE (kg/tow) by vessel size (LOA) for the Iceland scallop fishery in the Strait of Belle Isle, 2000.

Week	Dates	<35'	35-44'	45-54'	55-64'	Combined
1	June 5-11	30.0	26.9	27.3	-	28.2
2	June 12-18	29.6	23.6	24.5	-	25.7
3	June 19-25	33.3	26.5	24.0	-	28.6
4	June 26-July 2	33.0	24.7	23.0	-	28.8
5	July 3-9	31.5	24.9	23.1	-	27.2
6	July 10-16	32.5	29.7	25.3	-	30.2
7	July 17-23	28.5	26.8	25.6	-	27.4
8	July 24-30	30.2	23.9	22.8	-	26.2
9	July 31 – Aug 6	30.1	21.4	21.8	-	24.7
10	Aug 7-13	27.1	22.6	23.2	-	24.6
11	Aug 14-20	26.3	20.1	23.5	-	23.2
12	Aug 21-27	28.0	22.5	21.7	-	25.3
13	Aug 28 – Sept 3	30.1	20.4	21.1	-	25.2
14	Sept 4-10	29.2	25.2	24.5	-	27.4
15	Sept 11-17	28.6	29.1	22.4	-	27.6
16	Sept 18-24	26.9	25.8	-		26.6
	2000 Overall	29.8	24.4	23.6	-	26.6
	1999 Overall	34.7	28.1	25.2	-	29.9
	1998 Overall	37.9	33.0	27.8	-	33.4
	1997 Overall	40.1	33.9	26.0	43.1	33.9
	1996 Overall	45.3	29.7	24.4	54.4	32.1
	1995 Overall	27.2	26.3	23.6	27.2	25.9
	No. of vessels (2000)	13	15	4	-	32
	% of weight removed (2000)	42%	39%	13%	-	94%*

* 69.9 t of landings unaccounted for by logbook data

Table 16. Mean catch per tow (numbers & weights) and depths fished for Iceland scallops in the Strait of Belle Isle, 1995-2000. Based on research vessel surveys.

Year	# of sets	Depth fished (m)		Mean number/tow (± S.D.)	Mean weight (kg)/tow (± S.D.)
		Mean	Range		
1995	103	69.3	35-110	51.3 (±52.1)	5.33 (±5.19)
1997	148	66.6	22-110	23.8 (±33.0)	2.63 (±3.45)
1999	102	67.4	40-103	65.5 (±74.4)	7.36 (±8.48)
2000	63	73.3	37-116	32.2 (±25.3)	3.75 (±3.12)

Table 17. Mean and model shell heights (mm) of the Iceland scallop in the Strait of Belle Isle, 2000. Sources of data indicated.

Source	N	Mean shell ht. (mm) (± S.D.)	Modal shell Height (mm)	Range (mm)	
				Max.	Min.
Research sets	1,945	90.1 (±9.2)	90	118	19
Observer sets	4,876	83.7 (±8.6)	80	111	45

Table 18. Mean and modal shell heights (mm) of the Iceland scallop in the Strait of Belle Isle, 1995-2000. Based on research vessel surveys.

Year	N	Mean shell ht. (mm) (± S.D.)	Modal shell Height (mm)	Range (mm)	
				Max.	Min.
1995	3,405	86.8 (± 8.6)	90	111	24
1997	3,257	87.3 (± 8.9)	90	114	25
1999	5,053	88.6 (± 9.3)	90	117	4
2000	1,945	90.1 (± 9.2)	90	118	19

Table 19. Relative abundance (numbers and weights, kg round) of pre-recruit and commercial-sized scallop sampled along the Strait of Belle Isle in 2000.

Source	No. of sets	Total measured weight (kg)	Total measured number	Percent <60 mm	
				By weight	by number
Survey sets	63	230.17	1,945	0.10	0.46
Observer sets	20	NA	4,876	NA	0.98

Table 20. Frequency occurrence of one or more "shock" rings on shells of the Iceland scallop in the Strait of Belle Isle, 1999 and 2000.

Year	South of 51°25'N			North of 51°25'N			Overall		
	# of Sets	# scallop sampled	% with shock ring	# of Sets	# scallop sampled	% with shock ring	# of Sets	# scallop sampled	% with shock ring
1999	5	466	59.0	10	877	56.7	15	1,343	57.5
2000	23	447	13.0	40	1,488	18.7	63	1,935	17.4
Combined	28	913	36.5	50	2,365	32.8	78	3,278	33.8

Table 21. Biological meat yields, average meat weight and count for the Iceland scallop from the Strait of Belle Isle. No corrections made for epibiont load.

Year	N	Whole wt. (kg)	Meat wt. (kg)	x meat Wt. (g)	Count		Yield (%)
					#/lb.	#/500 g	
1995	921	105.3	10.79	11.7	39	43	10.3
1997	555	68.7	8.77	15.8	29	32	12.8
1999	444	58.0	7.22	16.3	28	31	12.4
2000	537	64.9	7.95	14.8	31	34	12.2

Table 22. Estimates of natural mortality for the Iceland scallop in the Strait of Belle Isle, 1995-2000. Clucker numbers are adjusted by a factor of 1.221 to allow for tow-induced disarticulation.

Year	Total		M		
	Live	Clucker	Overall	North of 51°25'	South of 51°25'
1995	3,548	411.5	0.18	0.20	0.12
1997	3,788	393.2	0.16	0.24	0.03
1999	5,148	580.0	0.17	0.20	0.07
2000	2,026	262.5	0.20	0.23	0.09

Table 23. Mean numbers, weights (kg), and size [arm radii (mm)] for four species of starfish north and south of 51°25'N in the Strait of Belle Isle, 1997, 1999 and 2000.

Area	No. of sets	Leptasterias			Crossaster			Solaster			Asterias		
		mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)
South of 51°25'	23	15.3 (±16.9)	1.8 (±1.5)	96.7 (±27.9	5.0 (±6.7)	0.5 (±0.7)	75.2 (±17.6)	0.2 (±0.7)	0.2 (±0.1)	92.8 (±27.3)	0	0	0
North of 51°25'	40	56.1 (±69.2)	5.1 (±6.3)	82.7 (±16.6)	20.4 (±26.5)	1.5 (±2.2)	65.9 (±14.9)	0.1 (±0.5)	0.03 (±0.1)	114.5 (±28.7)	0	0	0
Overall 2000	63	41.2 (±59.2)	3.9 (±5.3)	84.8 (±19.4)	14.7 (±22.7)	1.1 (±1.9)	67.0 (±15.6)	0.1 (±0.6)	0.02 (±0.1)	103.6 (±28.4)	0	0	0
Overall 1999	102	72.4 (±108.5)	6.3 (±9.2)	91.7 (±22.8)	19.1 (±34.7)	1.5 (±3.1)	72.6 (± 20.4)	0.4 (±0.9)	0.05 (±0.1)	91.4 (±26.8)	<0.1	<0.1	36.5 (±7.8)
Overall 1997	148	41.5 (±66.0)	3.9 (±6.3)	82.4 (±20.2)	14.2 (±25.7)	1.2 (±2.6)	67.5 (±15.5)	0.4 (±1.1)	0.06 (±0.2)	97.2 (±37.8)	<0.1	<0.1	85.0

Table 24. Estimates of minimum dredgeable biomass (t, round) in the Strait of Belle Isle (NAFO Div. 4R) in 2000. Total area surveyed is adjusted to reflect the cumulative ratio of "good" to "unsuitable" bottom using Roxann.

Bed	Total survey area				"Good" bottom (Roxann)		
	Size (n. mi.^{2})	No. of sets	x / tow (kg)	95% confidence bands (mean)	"good" bottom	Size (n. mi.^{2})	95% confidence bands (mean)
1	241.0	24	2.57	564.5 - 1,317.8 (x= 941.1)	44%	106	248.3 - 579.6 (x= 414.0)
2	128.8	13	5.26	622.3 - 1,436.1 (x= 1,029.2)	63%	81	391.4 - 903.1 (x= 647.3)
3	242.4	26	4.08	1,026.4 - 1,982.5 (x= 1,504.5)	47%	114	482.7 - 932.4 (x= 707.5)
all	612.2	63	3.75	2,775.6 - 4,174.1 (x= 3,474.8)	49%	301	1,407.7 - 2,129.8 (x= 1,768.8)

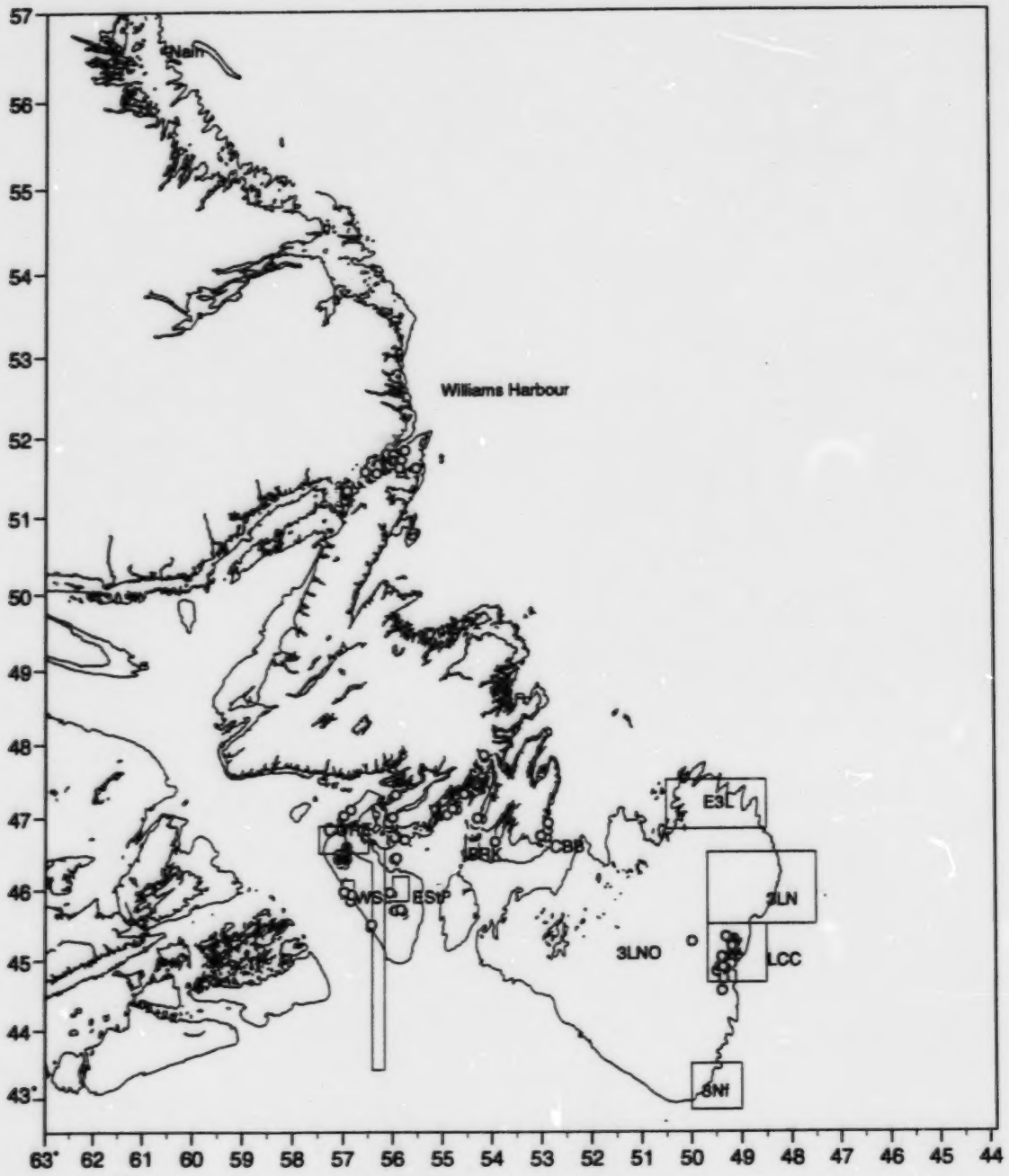
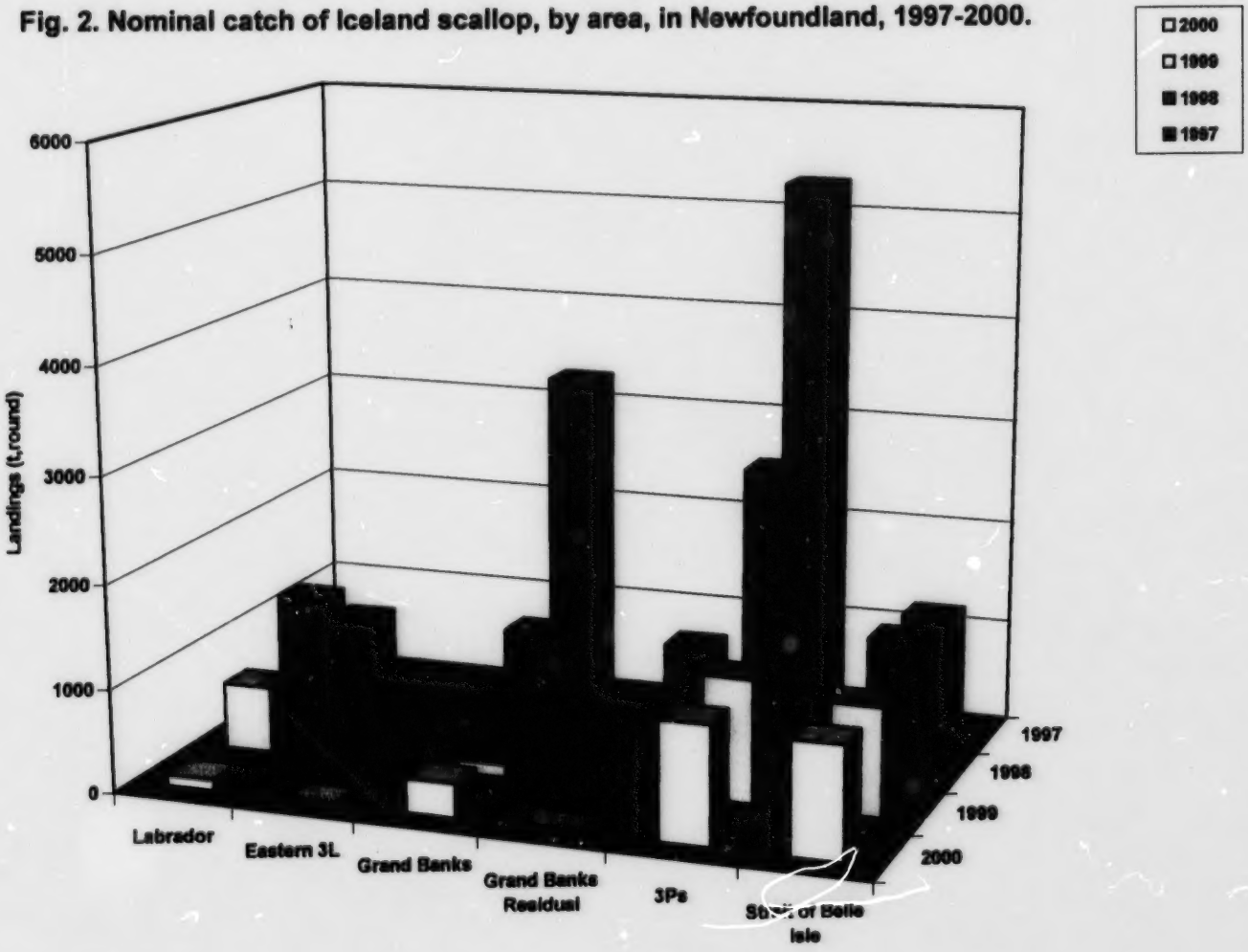


Fig. 1. Distribution of commercial effort for Iceland scallops [hollow circles] and sea scallops [solid circle], 2000. (E3L= Eastern 3L; 3LN=3LN; LCC= Lilly/Carson Canyons; 3Nf= NAFO Unit Area 3Nf; CBB= Cape Ballard Bank; PRK= Perch Rocks/Keys; EStP= Eastern St. Pierre Bank; WStP= Western St. Pierre Bank; CORE= Canada/France transboundary zone).

Fig. 2. Nominal catch of Iceland scallop, by area, in Newfoundland, 1997-2000.



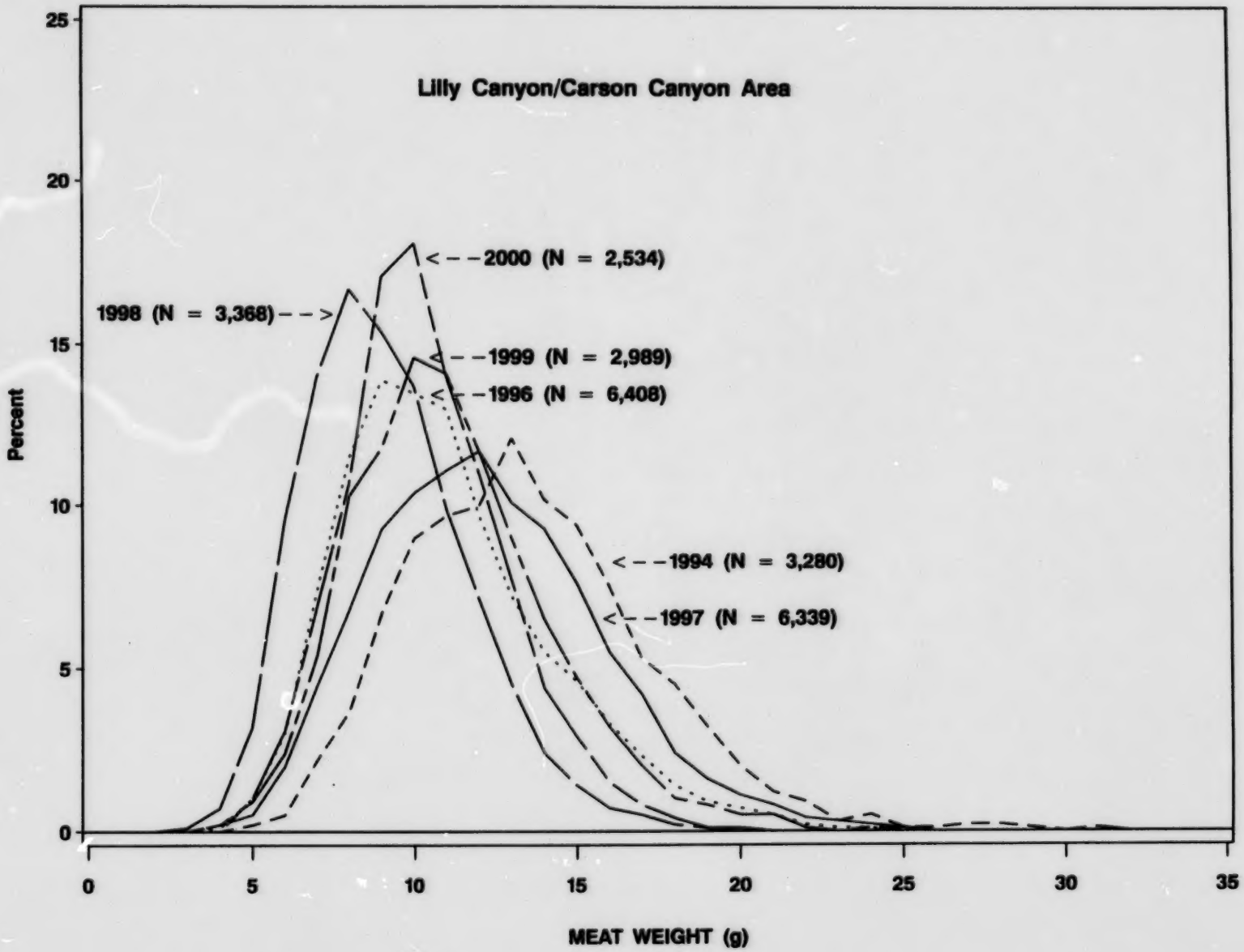


Fig. 3. Commercial meat-weight frequency distributions from the Lilly Canyon/Carson Canyon area, 1994 – 2000.

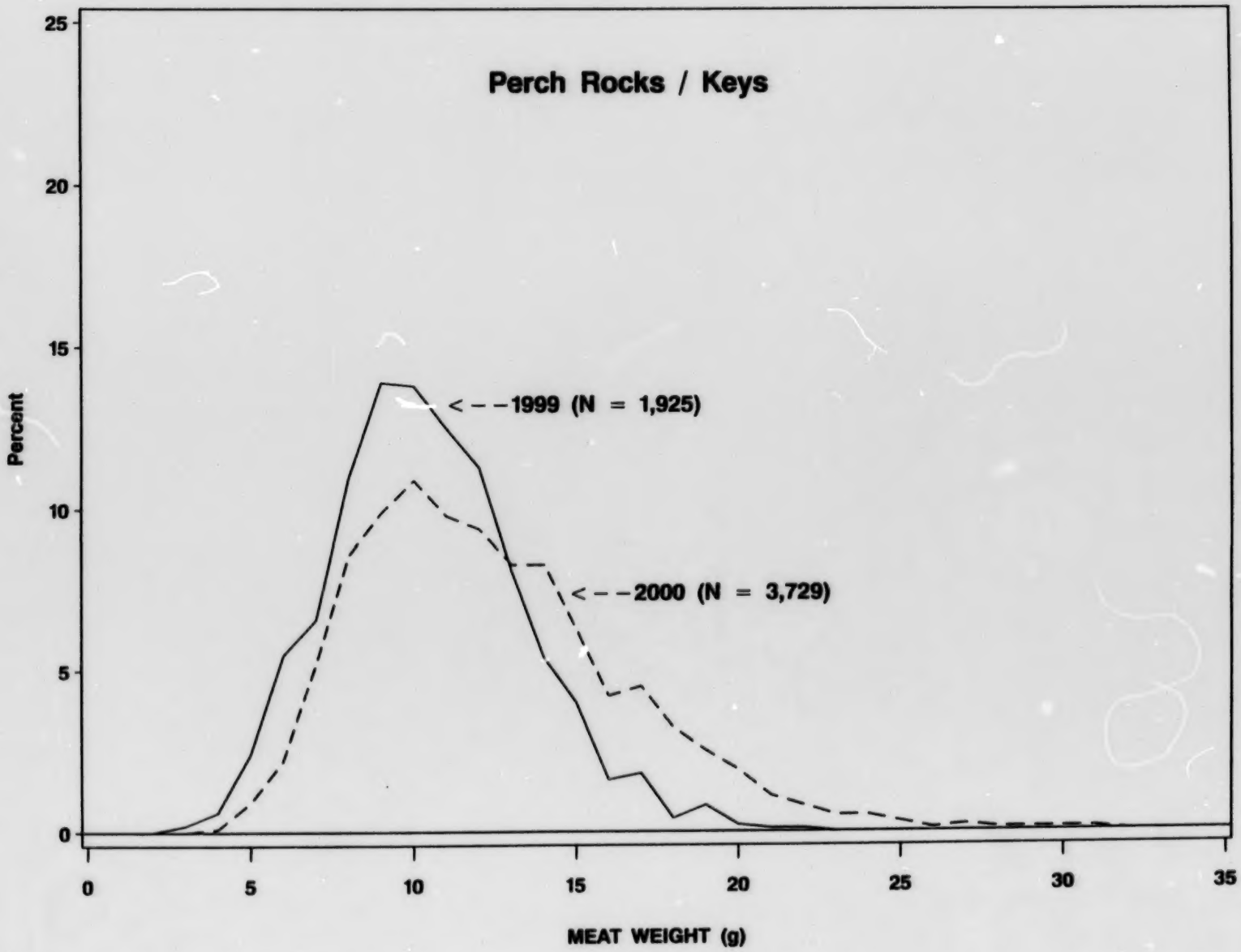


Fig. 4. Commercial meat-weight frequency distributions from the Perch Rocks/Keys area, 1999 – 2000.

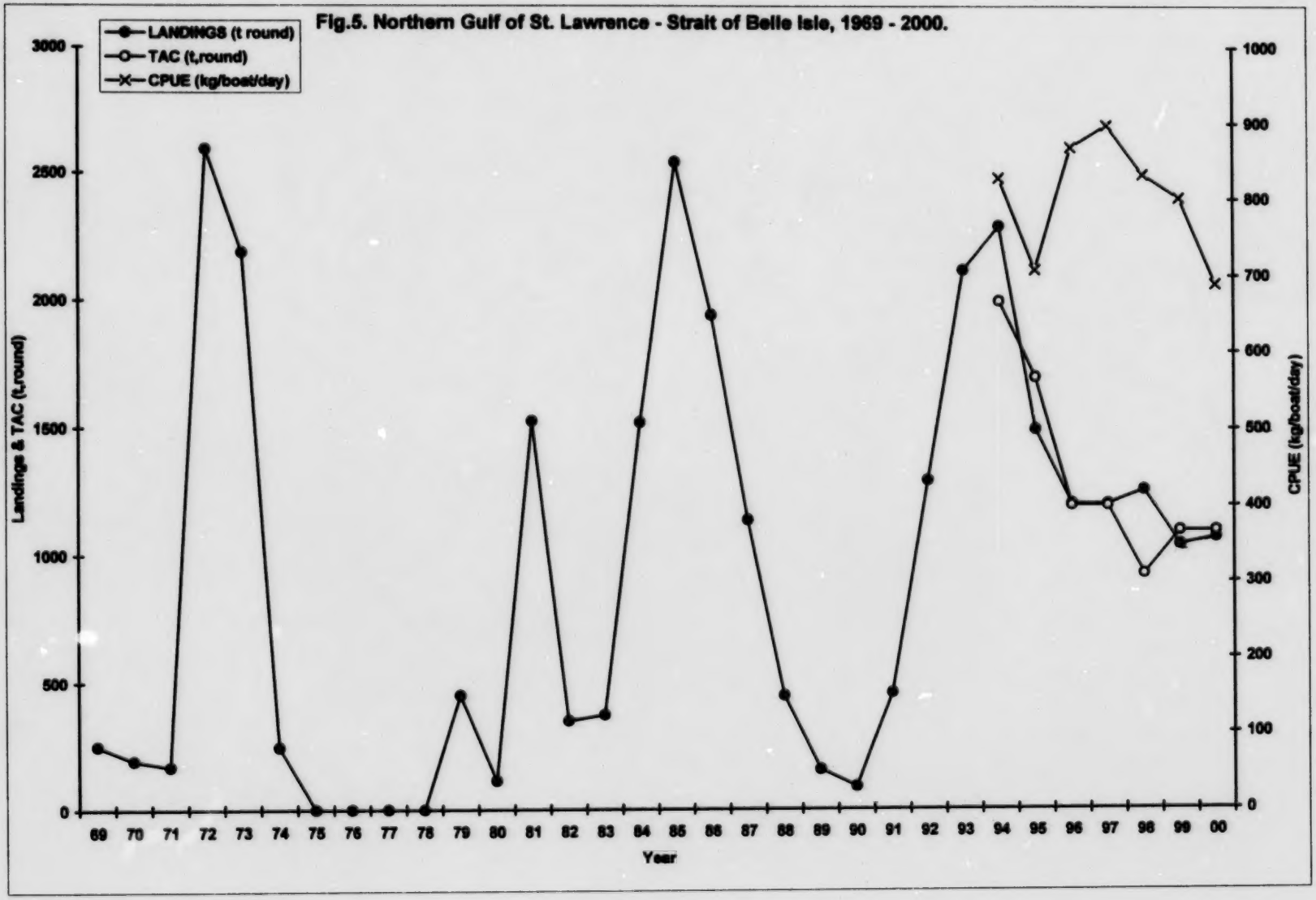


Fig.5. Northern Gulf of St. Lawrence - Strait of Belle Isle, 1969 - 2000.

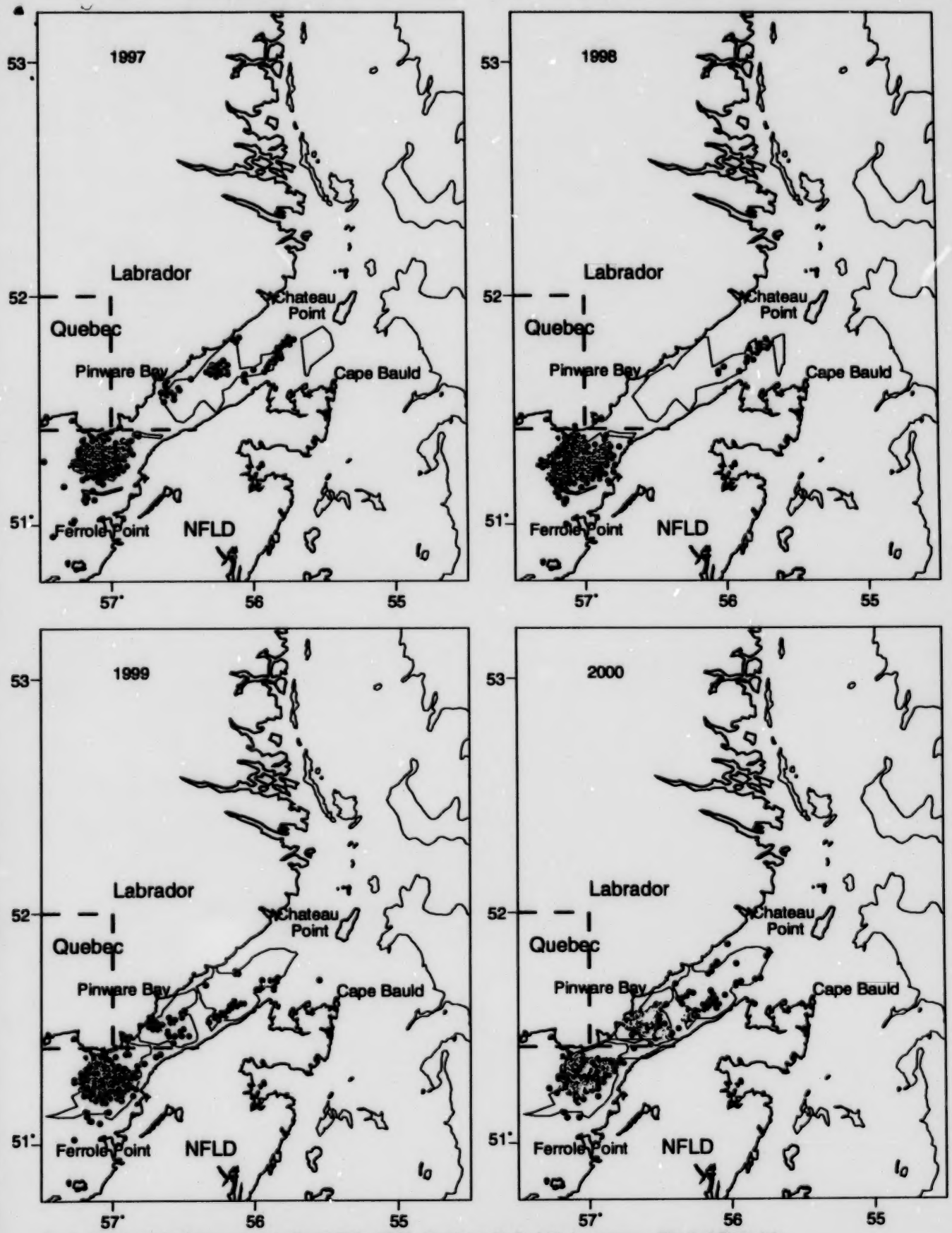


Fig.6. Distribution of commercial effort 1997 - 2000, Northern Gulf of St. Lawrence - Strait of Belle Isle.

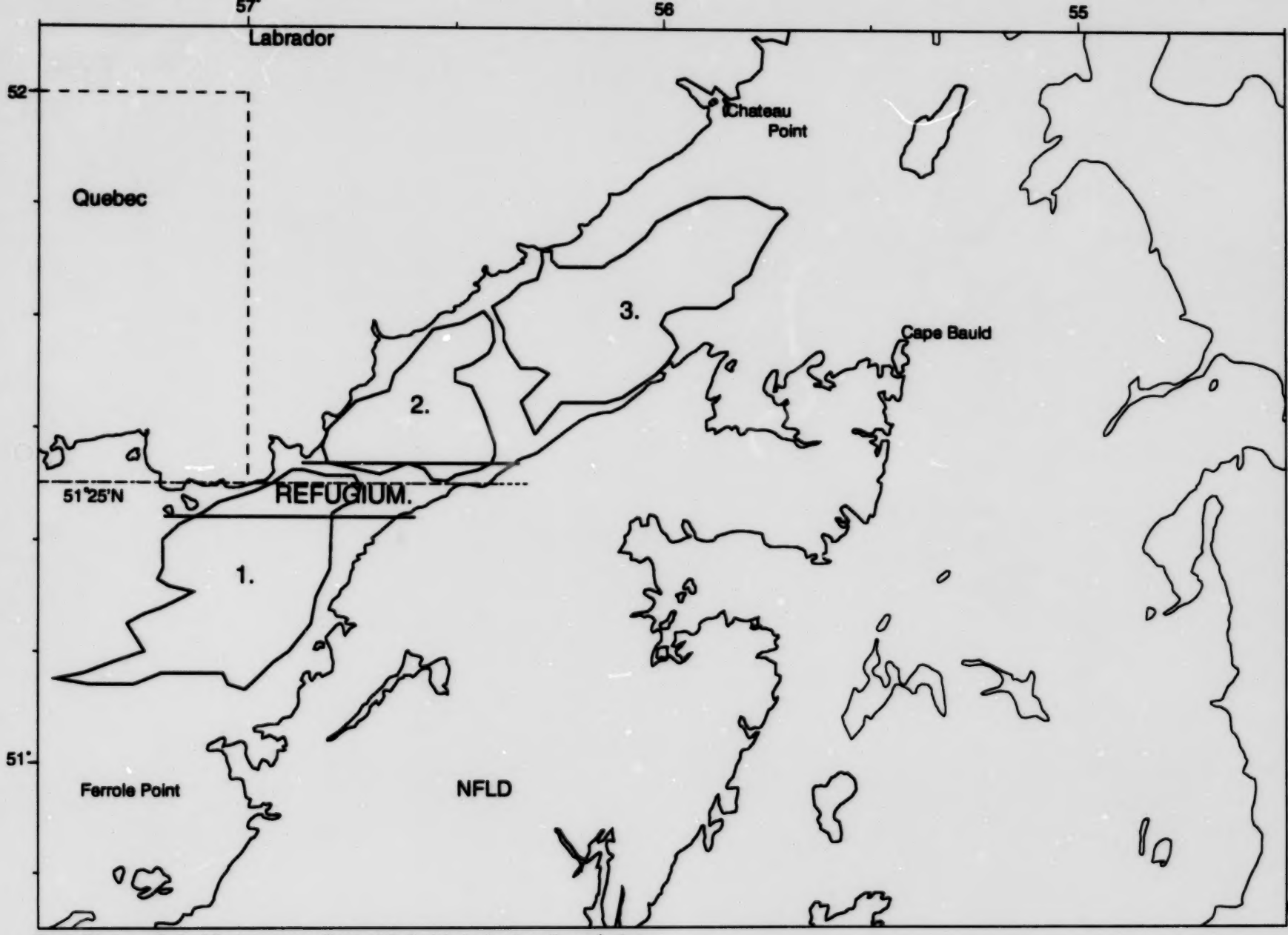


Fig.7. Northern Gulf of St. Lawrence, Strait of Belle Isle Iceland scallop refugium.

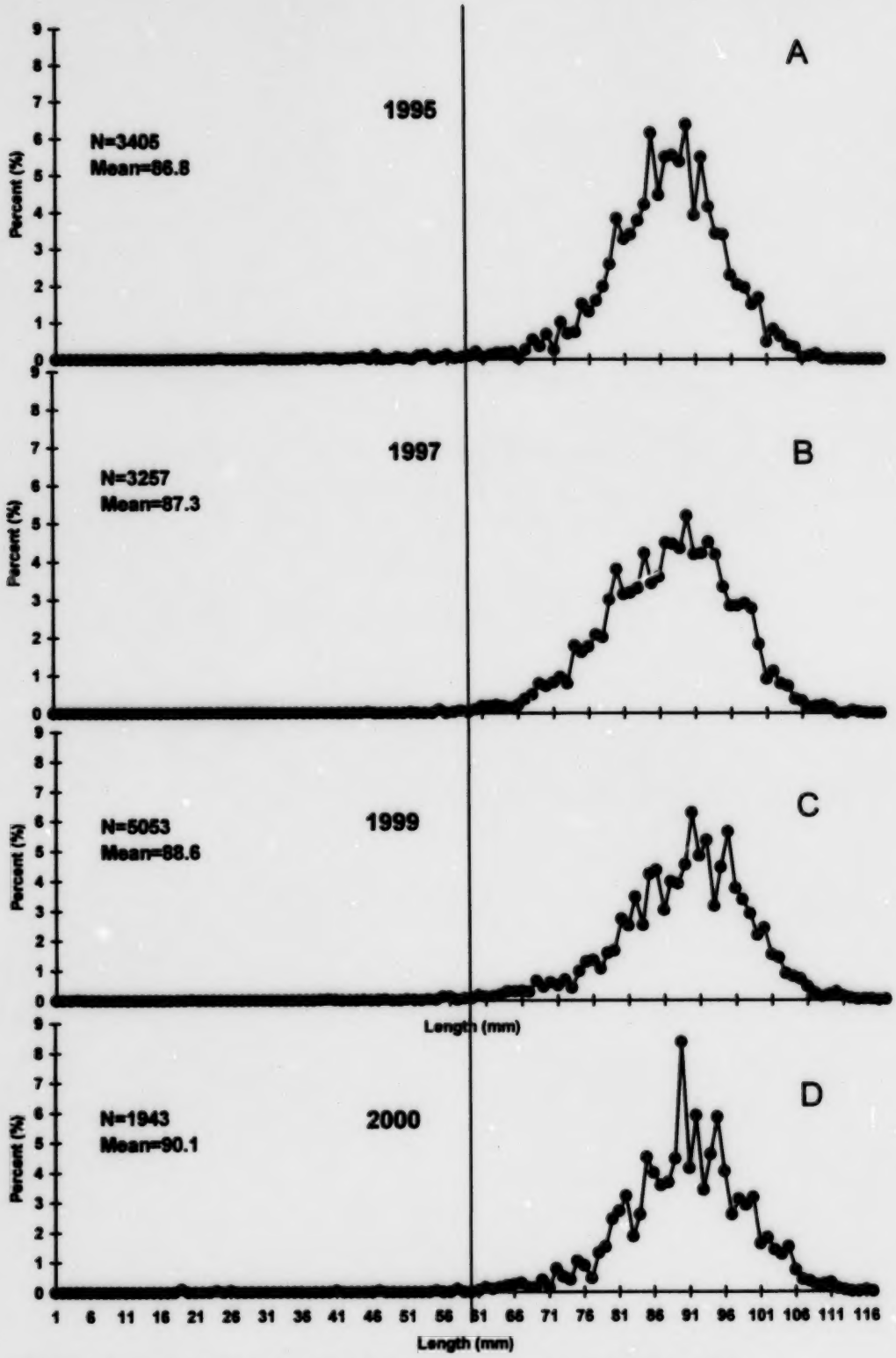


Fig.8. Size-frequency distributions (shell-height, mm) of the Iceland scallop, 1995, 1997, 1999 and 2000.

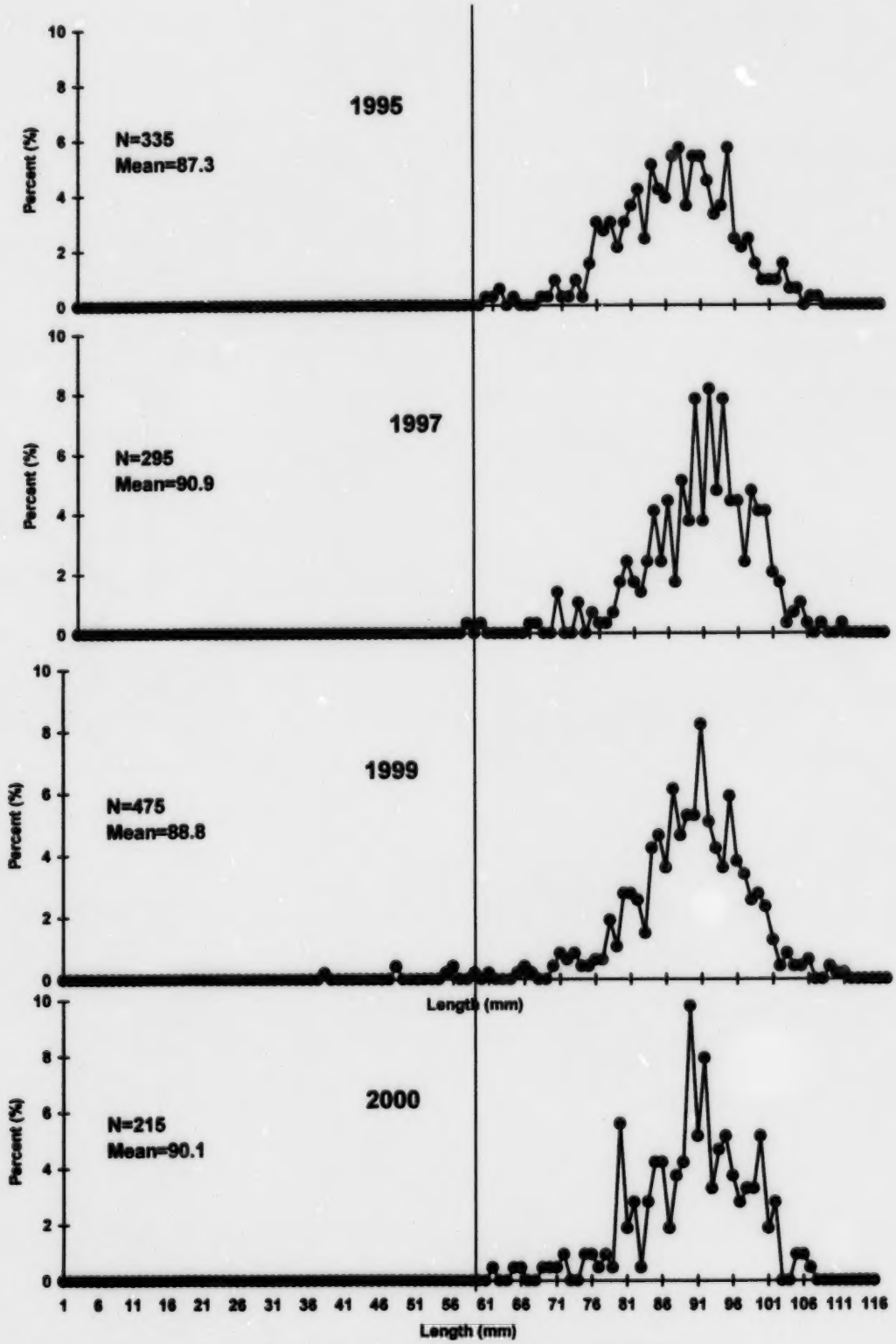


Fig.9. Size-frequency distributions (shell-height, mm) of the Iceland scallop cluckers, in the Strait of Belle Isle, 1995, 1997, 1999 and 2000.

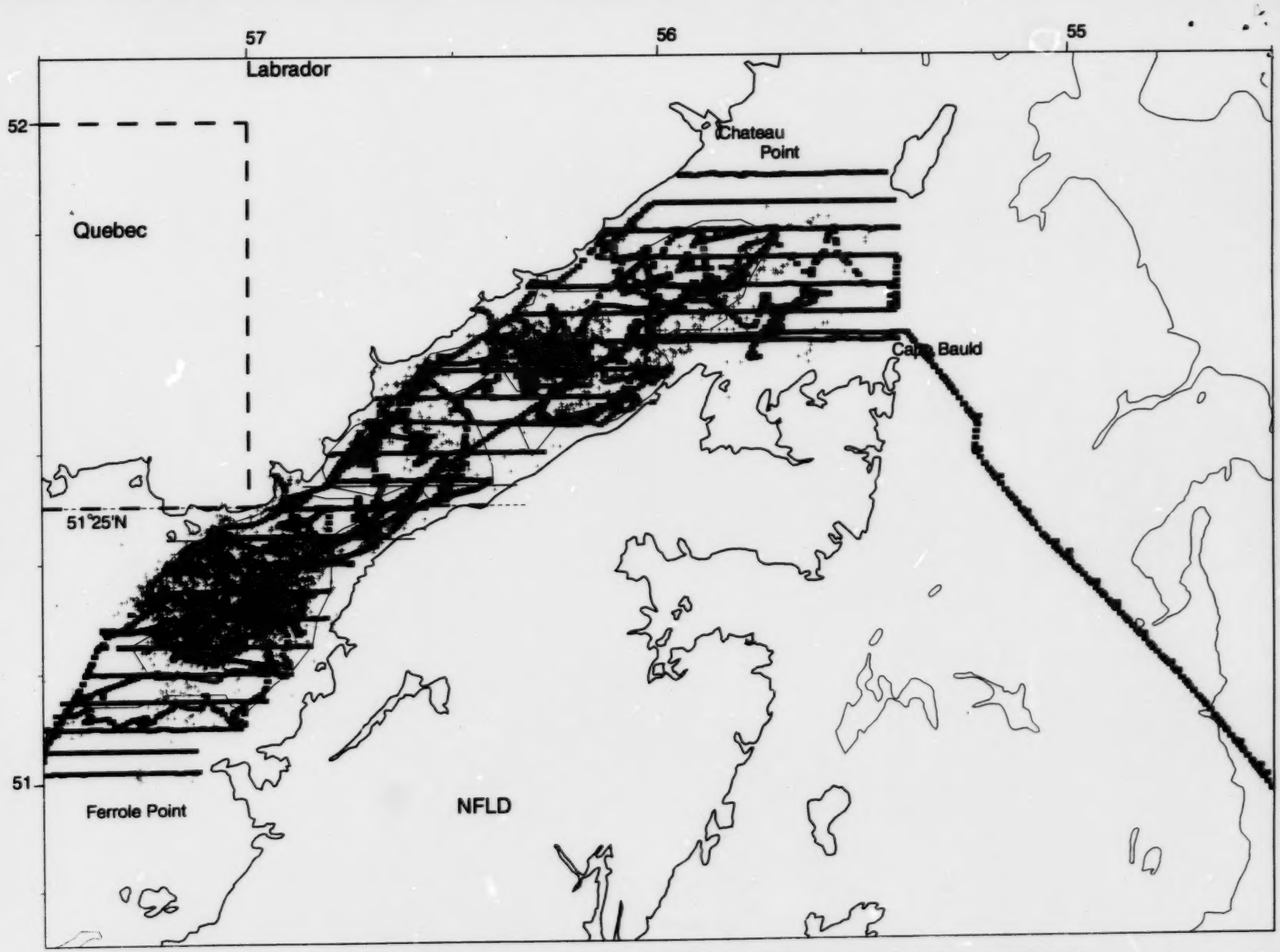


Fig.10. Roxann data for 4R: Green for grounds suitable for presence of scallops and red for unsuitable grounds. Distribution of historical fishing effort is shown in orange.

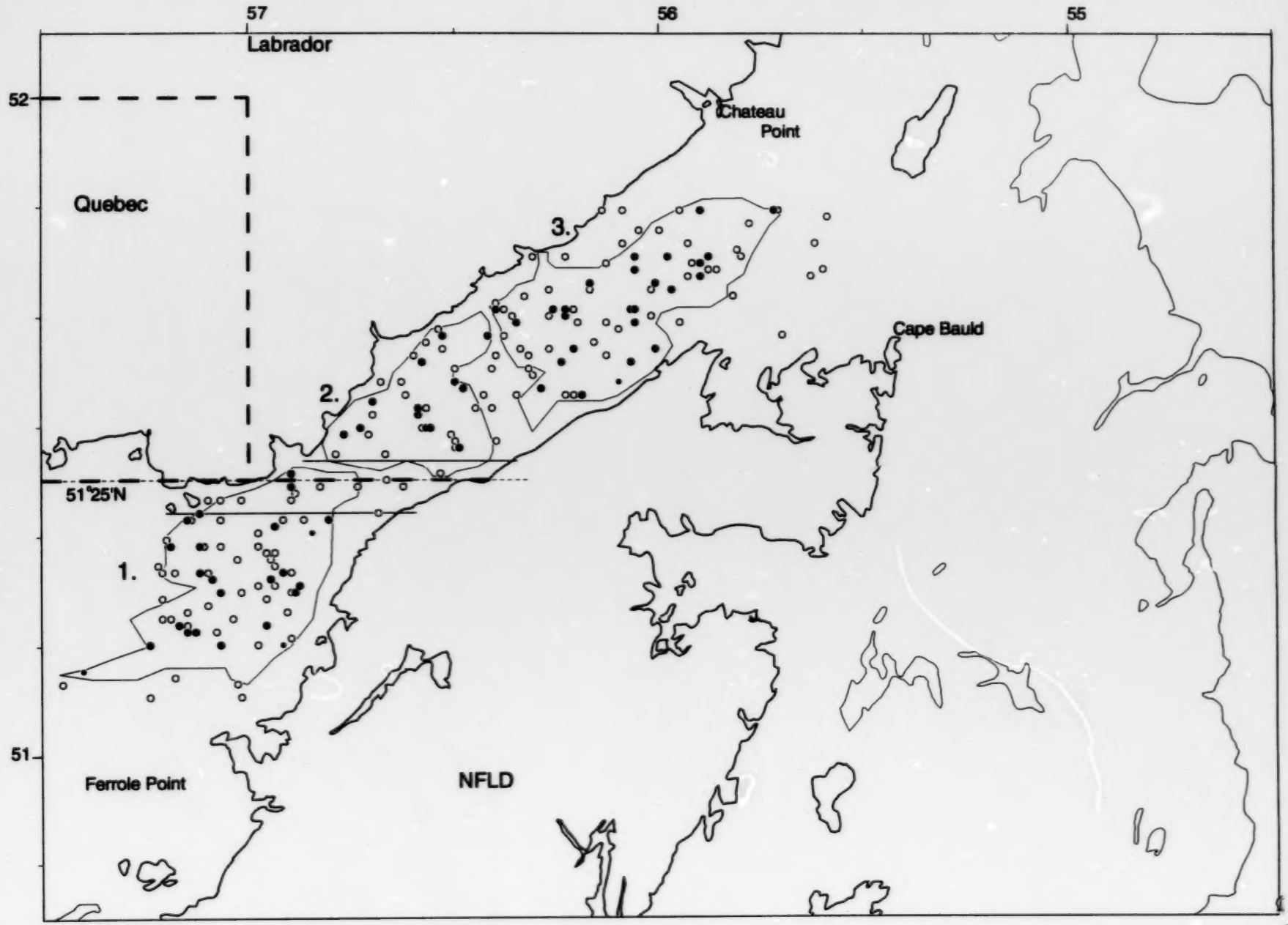


Fig.11. Research survey sets in 4R for 1997 [open circles] and 2000 [closed circles].